

VU Research Portal

Adolescent antisocial behaviours

Oostermeijer, S.

2017

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Oostermeijer, S. (2017). *Adolescent antisocial behaviours: Underlying cognitive and neurobiological processes*. [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam].

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

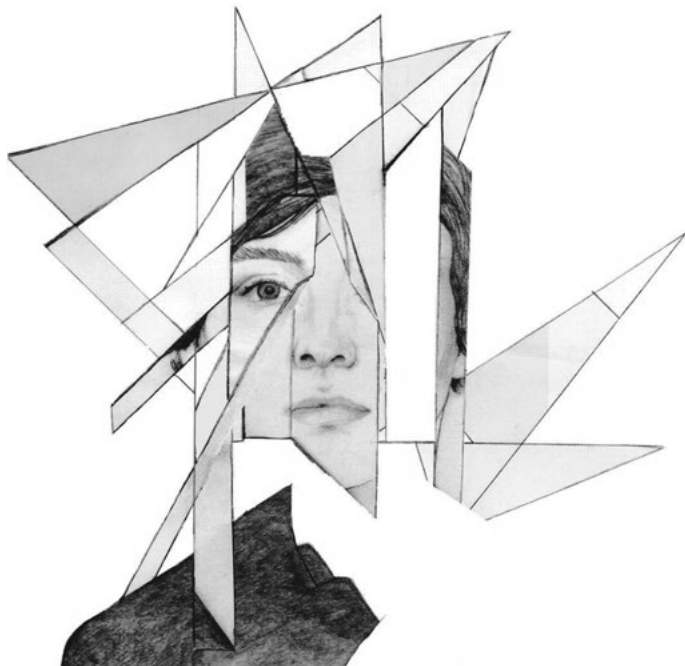
vuresearchportal.ub@vu.nl

Chapter 5

Executive Functioning and Conduct Problems in Adolescents with severe Antisocial Behaviours

S. Oostermeijer — L.M.C. Jansen — L.J.M. Cornet — A. Popma

In revision



Abstract

The aim of this study was to investigate whether EF was correlated to conduct problems (CP) in severely antisocial adolescents and whether EF could predict CP changes. CP were investigated at admission to (T1) and discharge (T2) from of compulsory residential treatment. At T1 94 adolescents were assessed and 58 adolescents at both T1 and T2. EF was measured at T1 with the Wisconsin Card Sorting Task assessing shifting and inhibition and the Tower Of London task assessing planning. Results showed poorer inhibition related to higher CP at T1, while better planning related to higher CP at T1 and T2. A linear regression model predicting CP at T2 (corrected for CP at T1, age, gender and treatment-length) showed no predictive values of EF. Current results indicated that none of the EF measures predict changes in conduct problems for severely antisocial adolescent. Implications for clinical practice and future research are discussed.

Keywords. Executive Functioning, Conduct Problems, Antisocial Behaviour, Adolescence, Residential treatment

A growing body of research is focusing on a neurobiological perspective of antisocial behaviours (Blair, 2004, 2010; Cornet, van der Laan, Nijman, Tollenaar, & de Kogel, 2015; Fishbein et al., 2009; Lee et al., 2014; Ogilvie, Stewart, Chan, & Shum, 2011; Vaske, Galyean, & Cullen, 2011; Yang & Raine, 2009). In this regard neuropsychological functioning, more specifically executive functions, are known to play a significant role. Executive functioning (EF) are cognitive abilities including planning, inhibition, working memory and cognitive flexibility that are involved in more complex cognitions such as decision-making, modifying behaviour and solving problems. EF is essential for human adaptive behaviour to constantly changing environments and it is essential for success in school, work and many every-day situations (Jurado & Rosselli, 2007). A meta-analysis exploring EF and a range of antisocial behaviours (e.g., delinquency, conduct disorder and psychopathy) showed a robust association with poor EF, with the largest effect sizes seen in studies focusing on oppositional defiant disorder/ conduct disorder (ODD/CD) and delinquency (Ogilvie et al., 2011). This highlights EF as an important neurobiological concept to be considered in research into antisocial behaviours. These EF abilities typically mature during adolescence and an increase in performance is observed during this time (De Luca et al., 2003; Huizinga et al., 2006). As such, adolescence is of particular interest when studying EF as the brain is still developing and disruptions in the neurodevelopmental processes will manifest (Lee et al., 2014).

The components of EF facilitate complex behaviours such as planning, goal-directed actions, decision making, organising and self-regulating, traditionally linked to the prefrontal cortex (PFC). It is now understood that EF is not solely related to the frontal lobes (Alvarez & Emory, 2006), but is also driven by interconnections between cortical and subcortical areas (Heyder, Suchan, & Daum, 2004). Notably, a meta-analysis of structural as well as functional imaging studies in antisocial individuals has reported abnormalities particularly in frontal brain regions, including the orbitofrontal cortex (OFC) and the dorsolateral prefrontal cortex (dl-PFC) (Yang & Raine, 2009). It has been argued that dysfunctions of the orbitofrontal cortex lead to impaired decision making in antisocial individuals (Blair, 2004). Structural and functional disruptions in frontal brain areas possibly manifest in poorer EF, which in turn facilitates impaired decision making and development of antisocial behaviour in antisocial populations.

The importance of longitudinal research with regards to antisocial behaviours has become more apparent in the last decade (Odgers et al., 2007; Piquero, 2008). Moffitt (1993) first introduced an influential theoretical framework in which two separate developmental trajectories of antisocial behaviour were proposed, an adolescent-limited and life-course-persistent type. The adolescent-limited type desists from antisocial behaviour, while the life-course-persistent type develops pathological persistent antisocial behaviour (Moffitt & Caspi, 2001). According to this theory adolescents that desist from antisocial behaviour (the adolescent-limited type) have no neuropsychological deficits related to their antisocial behaviour and desist due to their ability to adapt to changing contingencies. In a life-course persistent group, neurocognitive deficits have been identified, while this was absent in the adolescent-limited group (Moffitt & Caspi, 2001). However, more recently it has been argued that the adolescent-onset type often persists into adulthood and may also have neurodevelopmental origins (Fairchild, van Goozen, Calder, & Goodyer, 2013). Overall, research suggests that poor EF forms a neurobiological vulnerability to the development of antisocial behaviour and in addition it may be a risk factor for the persistence of such behaviours.

More insight from a neuropsychological perspective may also help to unravel why interventions do and do not work (Vaske et al., 2011). Poorer EF may facilitate the persistence of antisocial behaviours. It has been shown that EF plays a role in predicting treatment success (drop out and/or relapse) in pathological gambling (Álvarez-Moya et al., 2011; Goudriaan, Oosterlaan, De Beurs, & Van Den Brink, 2008) and substance abuse (Aharonovich et al., 2006; Turner, LaRowe, Horner, Herron, & Malcolm, 2009). For children with ADHD lower inhibition has been shown to be predictive of less behavioural change after methylphenidate treatment (van der Oord, Geurts, Prins, Emmelkamp, & Oosterlaan, 2012). Research on the predictive value of EF for treatment resistance of antisocial behaviours is scarce. Fishbein et al (2009) have shown that adult prison inmates lacking behavioural inhibition and an inability to shift responses were less likely to make progress in a standard correctional treatment programme. In addition, Cornet and colleagues (2015) found that there was a predictive effect of performance on a neuropsychological attention task in relation to treatment dropout among adult prisoners. Those who exhibit lower levels of attention skills were more likely to dropout of the intervention

programme. However, EF tasks in this specific study were not related to behavioural treatment outcome measures. On the other hand, Mullin and Simpson (2007) showed that poorer EF was related to a greater reduction in negative behaviour in response to an enhanced thinking skills training in a delinquent adult sample. Research on the predictive value of EF for behavioural changes among children and adolescents is even more limited. An explorative study by Van Bokhoven and colleagues (2004) in young children with disruptive behaviour disorder is one of few regarding this issue. They found no predictive effect of performance on a response preservation task in relation to treatment outcome. More research is needed to investigate whether EF can help to predict behavioural changes in antisocial populations. Adolescence is of particular interest, as this is a period of rapid developmental changes and neuroplasticity (Lee et al., 2014).

The aim of this study was to 1) investigate whether executive functioning (EF) was correlated to conduct problems in severely antisocial adolescents and 2) whether EF can predict changes in conduct problems (CP) in severely antisocial adolescents. As mentioned earlier, EF is important for adaptive behaviour to changing environments and essential for many everyday situations (Jurado & Rosselli, 2007). Antisocial adolescents with poorer EF are expected to be least susceptible to behavioural changes (i.e., more prone to persist their problem behaviours). It is hypothesised that 1) poorer EF will correlate with more conduct problems at admission and discharge of a residential treatment programme and 2) adolescents with poorer EF will show less behavioural change in terms of their conduct problems.

Method

Participants

Participants were recruited from a compulsory residential treatment facility for adolescents with severe problem behaviours in Amsterdam, the Netherlands. A new compulsory residential treatment programme was implemented in 2008 for treating highly problematic adolescents. This residential treatment programme has been described and evaluated by Nijhof and colleagues (Nijhof, Veerman,

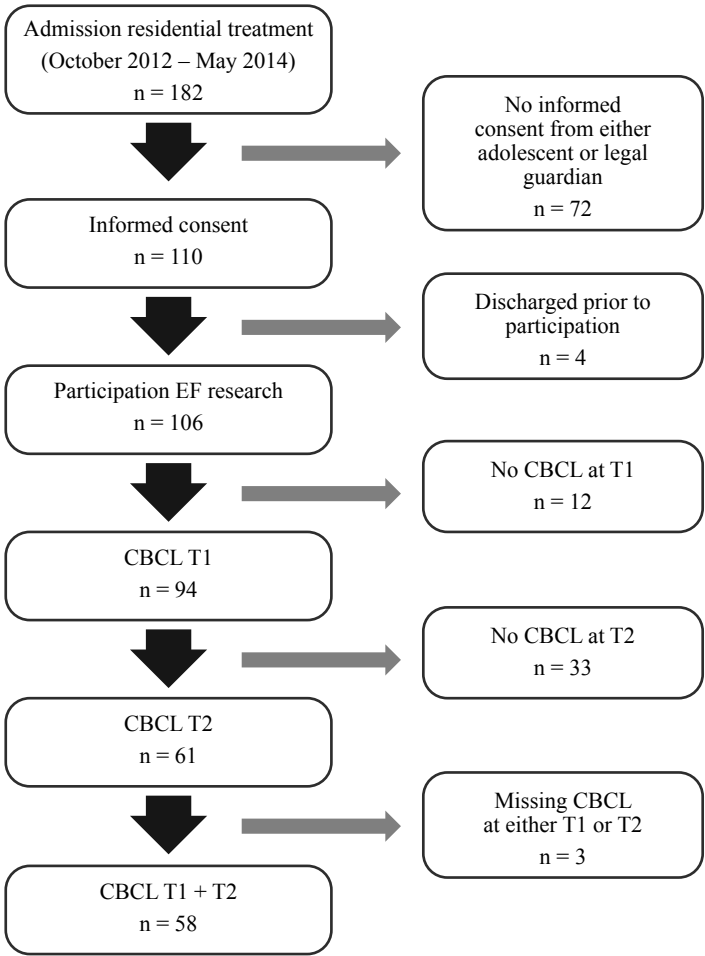
Engels, & Scholte, 2011). The standard treatment programme offers daily routine, education, leisure activities and homework assistance, which are all important aspects of the basic stable environment. In addition, the adolescents receive individual complementary interventions, such as cognitive behavioural therapy (CBT) or eye movement desensitization and reprocessing (EMDR) therapy. The residential treatment programme is based on the social competence-model (Slot & Spanjaard, 1999) and comprises five treatment stages, which move from a closed to an open and autonomous environment. The main goal is to offer the adolescents future perspective.

Adolescents admitted between October 2012 and May 2014 were asked to participate in the current study (see Figure 1). Consent to participate was obtained from all participants and their parent(s) or legal guardian. The study was approved by the local ethical committee of the VU medical centre Amsterdam (registration number 2002/178, ABR number NL28476.029.09). In total, 106 adolescents between 12 and 17 years old ($M = 15.3$, $SD = 1.2$) participated. The average IQ was 82.4 ($SD = 12.9$, range 59-112, $n = 65$) as indicated by the Wechsler Intelligence Scale for Children (WISC) which was obtained from file information, 62.3% was male and 37.9% was of western ethnicity. The treatment length varied between 2 to 94 weeks ($M = 28.8$, $SD = 15.2$). Within 3 to 4 weeks after admission participants were screened for Disruptive Behaviour Disorders (Module E) using the Diagnostic Interview Schedule for Children IV (DISC-IV) (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). This instrument is a fully structured diagnostic instrument which uses diagnostic criteria from the DSM IV.

Behavioural data was collected via questionnaires filled in by the group care worker from the residential facility, who was acting as an individual mentor at time of admission (T1) and discharge (T2). Collecting the behavioural data was not always successful, leading to attrition of the initial sample (see Figure 1).

Figure 1

Flow diagram of the study sample.



Note. EF= executive functioning, CBCL= child behavioural checklist, T1= assessment at admission, T2= assessment at discharge.

Measures

Conduct Problems

The Child Behaviour Checklist ([CBCL] official Dutch version 2001, parent-report 6-18 years) was used to assess conduct problems (Achenbach et al., 2008; Verhulst, Van der Ende, Koot, 1996). Each CBCL was filled in by a group care worker from the residential facility, who was acting as a mentor for the specific adolescent at time of admission (T1) and when leaving the facility (T2), related to the problem behaviours of that particular week. Using the CBCL, a total of six DSM-oriented scales can be assessed. The current study selectively used the scale Conduct Problems composed of 17 items. Each item was answered with a Likert scale consisting of 'not true (1)', 'sometimes/ somewhat true (2)', or 'often/ totally true (3)'. Converted T-scores between 65 and 69 indicate a subclinical range of conduct problems, and T-scores above 69 indicate clinically relevant problems.

Executive functioning

Executive functioning (EF) was assessed with two widely used complex EF tasks, the Wisconsin card-sorting task (WCST) and the Tower of London (TOL). Computerised versions of the tests were used. For both tasks the script from the Milisecond Test Library were used with the Inquisit 3 desktop edition (Milisecond software; <http://www.millisecond.com/download/library>). Trained students attended the session and provided guidance during the tests. Students were specifically instructed not to give any assistance during the tasks, only clarifying task instructions when necessary.

Research has shown that although EF components are interrelated, such complex EF tasks may tap into separate components (Miyake et al., 2000). The WCST is focused on 'cognitive flexibility' or shifting and has appeared to be useful in predicting competency in everyday life (Strauss, Sherman, & Spreen, 2006). During the WCST the participant is asked to match cards presented on the computer screen with a set of four cards that differ in their features (colour, form, and number). The participant is instructed to match the cards, however is not told that the matching feature may change. After feedback for each card (correct or incorrect) is received and after correctly matching 10 consecutive

cards based on one of the features, the matching feature changes. Such a shift occurs 6 times, or until 128 cards are presented. Research has shown poor WCST performance in antisocial populations on the perservative errors and categories obtained (Morgan & Lilienfeld, 2000), poor conceptual preservation (Lueger & Gill, 1990) and less total correct (Kim, Kim, & Kwon, 2001). It has been mentioned that studying more global measures of EF may miss crucial information (Séguin, Pinsonneault, Parent, & Séguin, 2015) and it is important to research EF concepts more specifically. For the WCST it has been argued that in addition to traditional scores (e.g., categories complete and perservative errors), other scores should be taken into account, including non-perservative errors reflecting inhibitory components of executive functioning (Steinmetz & Houssemand, 2011). Shifting is a crucial component of the WCST perservative errors, while inhibition seems less important (Miyake et al., 2000). As such, the current study will investigate two different measures of the WCST thought to assess different components of EF, the perservative errors and non-perservative errors.

The TOL task (a variation to the more classic task the Tower of Hanoi) is focused on detecting deficits in planning ability, a central component in problem-solving and attaining goals (Krikorian, Bartok, & Gay, 1994). This planning ability has been thought to be mostly dependent on the inhibitory component of EF (Miyake et al., 2000). However, it has been shown that planning time during the TOL was independent of the performance reflected by the total TOL score (Krikorian et al., 1994; Shallice, 1982). The TOL assesses planning ability by presenting 12 problems with increasing difficulty. The participant is presented with three pegs of different heights and three beads in different colours arranged on the pegs. Each problem involves a different arrangement of the beads that needs to be reproduced in a certain number of steps or moves. For each problem three points are earned if a solution is reached in one attempt, two points if the solution is reached in two attempts, one point if the solution is reached in three attempts and zero points if the solution is not reached within the three attempts. The TOL score ranges from 0 to 36 points. The larger the number of excess moves the poorer the problem solving ability and the lower the TOL score (Krikorian et al., 1994; Shallice, 1982).

Statistical analyses

Firstly, descriptives of the main study variables were computed. Correlation-analyses were performed to investigate the relationship between conduct problems at T1, T2 and the EF measures at T1. Secondly, linear regression analyses were conducted for each EF measure to investigate whether EF predicts conduct problems at T2, when controlling for conduct problems at T1. The EF score was entered as a predictor, and CP at T2 as the dependent variable. To control for conduct problems at T1, CP at T1 was entered as an additional predictor. Multi-collinearity statistics were investigated to check whether this causes potential biases in the regression models. Furthermore, an additional linear regression model investigated whether age, gender and treatment duration influenced results.

Results

In total 98 participants completed the DISC interview of which 12.2% fulfilled the criteria for Attention-Deficit/Hyperactivity Disorder (ADHD), 16.3% for Oppositional-Defiant Disorder (ODD) and 35.8% for Conduct Disorder (CD). Descriptives of the main study variables are shown in Table 1. From the participants who participated in the EF measures ($n=106$), one subject solely participated in the WCST and another solely in the Tower of London resulting in a sample of 105 adolescents for the EF measures. The mean difference score for CP ($CP\ T2 - CP\ T1$) was 0.24 ($SD\ 5.46$) ranging from -9 to 16.00, indicating both increases and decreases in conduct problems within the current sample. Within the current sample 54.5% showed no changes and/or negative changes regarding conduct problems during the standard residential treatment programme.

Correlation analyses revealed significant correlations between WCST non-perservative errors and CP at T1 ($r=.215$, $p<.05$) and TOL scores and CP at T1 ($r=.233$, $p<.05$) and T2 ($r=.360$, $p<.005$). There were no significant correlations between WCST preservative errors and CP at T1 or T2.

Linear regression analyses

Firstly, it was investigated whether the EF measures could predict conduct problems at T2 when correcting for conduct problems at T1. The model including perservative errors and non-perservative errors, and TOL explained a significant amount of variance in conduct problems at T2. The TOL scores showed unique contribution (see Table 2). It has been debated whether multi-collinearity could bias the results, however VIF values less than 5 and tolerance values above .20 do not raise much concern (Menard, 1995).

When including age, gender and treatment length as covariates in regression analyses predicting CP at T2, results showed no significant contribution for either of these covariates (see Table 3). Furthermore, the TOL score no longer showed unique contribution in the corrected model. In addition, results indicated no interaction effects of TOL scores with gender or age.

Table 1
Descriptives for the sample at T1.

	n	Mean	S.D.	Range
T1 Conduct Problems	94	65.4	7.5	50 – 84
T2 Conduct Problems	61	65.5	7.6	50 – 84
WCST - Perservative errors	105	13.6	10.2	0 – 51
WCST - Non-perservative errors	105	30.3	14.7	2 – 73
Tower of London score	105	28.8	4.3	17 – 36

Note. T1= assessment at admission, T2= assessment at discharge, WCST = Wisconsin Cart Sorting Test.

Table 2

Linear regression with EF measures predicting CP at T2, when correcting for CP at T1.

Dependent	Predictors	F	R ²	B	SE	β	t	p	VIF	tol
CP T2		5.299**	.298							
	CP T1			.425	.136	.403	3.125	.003	.843	1.187
	WCST PE			-.035	.089	-.061	-.393	.696	.585	1.710
	WCST non-PE			-.015	.055	-.041	-.265	.792	.601	1.663
	TOL			.371	.167	.282	2.230	.030	.874	1.114

Note. CP= Conduct Problems, T1= assessment at admission, T2= assessment at discharge, WCST= Wisconsin Cart Sorting Test, PE= perservative errors, TOL= Tower of London. * $p < .005$ and ** $p < .001$

Table 3

Linear regression with covariates age and gender.

Dependent	Predictors	F	R ²	B	SE	β	t	p	VIF	tol
CP T2		3.420*	.347							
	CP T1			.448	.144	.421	3.107	.003	1.268	.789
	Gender			-1.760	1.622	-.164	-1.085	.284	1.567	.638
	Age			-.009	.608	-.002	-.015	.988	1.168	.856
	Treatment length			.008	.007	.159	1.252	.217	1.108	.902
	PE			-.050	.098	-.086	-.511	.612	1.945	.514
	Non-PE			-.034	.059	-.094	-.570	.572	1.866	.536
	TOL			.260	.191	.198	1.364	.179	1.447	.691

Note. CP= Conduct Problems, T1= assessment at admission, T2= assessment at discharge PE= perservative errors, TOL= tower of london. * $p < .005$ and ** $p < .001$

Discussion

The aim of this study was to 1) investigate whether executive functioning (EF) was correlated to conduct problems (CP) in severely antisocial adolescents and 2) whether EF can predict changes in terms of their CP. It was hypothesised that 1) poorer EF would correlate with more conduct problems at admission and discharge from residential treatment and 2) adolescents with poorer EF would show less behavioural change regarding their conduct problems. EF was assessed at admission with the Wisconsin Card Sorting Task (WCST) assessing shifting and inhibition and the Tower Of London (TOL) task assessing planning abilities. Adolescents in the current sample showed poor performance on the inhibitory component of the WCST, but not the shifting component. Planning abilities on the TOL ranged from poor to good performance. Results showed that poorer inhibition was related to higher conduct problems at admission, while better planning was related to higher conduct problems at both admission and discharge. None of the EF measures predicted conduct problems at discharge when correcting for conduct problems at admission, age, gender and treatment-length.

Firstly, adolescents within the current sample showed particularly poor performance regarding the inhibitory component of the WCST, i.e., the non-perservative errors (Mean 30.2, S.D. 14.7). Performance on the shifting component of the WCST was not atypical, i.e., the perservative errors (Mean 13.6, S.D. 10.2). Other studies have shown that perservative errors and non-perservative errors during the WCST of typical adolescents around age 15 vary between 12.3 – 21 for perservative errors and 14.8 – 19.2 for non-perservative errors (Heaton, Chleune, Taley, Kay, & Curtiss, 1993; Huizinga & van der Molen, 2007; Lin, Chen, Yang, Hsiao, & Tien, 2000). This indicates poor performance in terms of the inhibitory component, but not for the shifting component of EF. Mean planning abilities of were poor compared to typical adolescents (Krikorian et al., 1994). However, the TOL scores within the current sample ranged from poor to good planning abilities (17–36). Concluding, adolescents in the current study showed poor performance in terms of the inhibitory component, but not for the shifting component of EF and planning abilities ranged from poor to good.

Secondly, our results showed that conduct problems were indeed related to EF. We hypothesised that poorer EF would correlate with more conduct

problems at admission to and discharge from compulsory residential treatment. Results were only partly in line with this hypothesis. Poorer inhibition, as expressed in the inhibitory component of cognitive flexibility (non-perservative errors of the WCST), was related to more conduct problems at admission. This is in line with the most recent meta-analysis conducted by Ogilvie and colleagues (2011) which showed that poorer EF was related to more antisocial behaviours. Contrary to this, current results also showed that better planning abilities, as expressed in higher TOL scores, were related to more conduct problems at admission and discharge. This suggests that distinct EF abilities are differentially related to severe conduct problems of adolescents within the residential treatment programme. Interestingly, Bergvall and colleagues (2001) found similar results for seriously adult violent offenders, who had impairments in shifting attention, i.e., extra dimensional shifting, but had good working memory and planning abilities compared to controls and individuals with mental retardation. As such, the relation between EF and antisocial behaviours may not be as unitary as earlier research has suggested (Ogilvie et al., 2011). It has been shown that executive function tasks that have been typically validated as being sensitive to frontal lobe functioning, may not be completely unitary and contribute differentially to complex executive functioning (Miyake et al., 2000). As such, it may be of importance to recognise diversity in EF components when researching the relationship between EF and adolescent antisocial behaviours.

The main aim of this study was to investigate whether EF can predict changes in conduct problems (CP). It was hypothesised that adolescents with poorer EF would show less behavioural change in terms of conduct problems. Results indicated that (when controlling for conduct problems at admission, age, gender and treatment length) none of the EF measures contributed to predicting conduct problems at discharge. Previous literature regarding antisocial behaviour and treatment has shown contradicting results. Fishbein and colleagues (2009) indicated subjects with poor EF were less likely to progress in a standard correctional treatment programme. While Mullin & Simpson (2007) showed poor EF was related to improvement, the current results indicated no predictive value of EF for behavioural change in terms of conduct problems. This could indicate that general research on antisocial behaviours and treatment outcomes may not be applicable to adolescents in residential treatment and/or younger antisocial populations. The results of van Bokhoven and colleagues

(2004) showed no predictive value of a response preservation task in relation to treatment outcome in young children with disruptive behaviour disorder. More recently, Cornet and colleagues (2015) showed similar results for adult prisoners. Adult prisoners with poor concentration performance were more likely to dropout of treatment, however none of the other EF measures were related to any of the treatment outcome measures. As such, more research into treatment outcome and EF in varying antisocial populations is necessary to understand whether, and how EF contributes to antisocial behaviours and its persistence.

As mentioned earlier, the current study investigated a unique sample of adolescents in compulsory residential treatment, about which little is known about the characteristics related to behavioural change and/or treatment outcomes. In 2008, a new compulsory residential treatment programme was implemented in the Netherlands for treating highly problematic adolescents. Nijhof and colleagues (2011) showed that for this new residential treatment programme, group care workers reported an overall increase of externalising behaviours. This is in line with the current sample, in which approximately half of the adolescents showed no improvement or even worsening of conduct problems as reported by their group care workers. Nijhof and colleagues (2011) discuss two possible explanations for this increase of problems as reported by group care workers. Firstly, it was proposed that group care workers might over report problem behaviours because they find longer treatment necessary. It should be considered that this is a valuable and professional opinion and as such reporting higher conduct problems still identifies a very problematic group of adolescents. Secondly, the authors argued that group care workers might overemphasise problems for adolescents in this relatively new treatment programme, because they want to stress the high severity of problems within this new adolescent sample. However, the current study has shown that several years after implementation of this new treatment programme (~3 years), group care workers still report a significant amount of adolescents who do not improve or even worsen in terms of externalising behaviours. Research on residential treatment programmes for adolescents has shown modest positive effect sizes, however it should be noted that negative effect sizes have also been reported (Knorth, Harder, Zandberg, & Kendrick, 2008; Souverein, Van der Helm, & Stams, 2013). Earlier research has pointed out that 20 to 40% of adolescents in general residential treatment do not improve and for some problems, worsen (Harder, Knorth & Zandberg, 2006). The current study showed that this 'small'

proportion could be considerably larger and points out that there could be a group for whom compulsory residential treatment can result in worsening of conduct problems. It should be noted that the current study sample specifically involves *compulsory* treatment, while general residential treatment does not necessarily involve compulsory treatment. It is unclear whether there are specific differences within compulsory and non-compulsory residential treatment programmes.

A possible explanation for the worsening of conduct problems may involve controlling intervention strategies (e.g., setting rules and boundaries) of group care workers. Bastiaanssen and colleagues (2014) showed that for younger children (aged 5 to 12) in residential treatment settings, higher levels of controlling interventions by group care workers children was associated with an increase in externalising behaviours. In turn, they showed higher externalising behaviours led to more controlling interventions by group care workers. The lack of improvement in conduct problems shown in the current study underlines the importance of researching predictive factors for treatment outcome (progress as well as worsening of problem behaviours) in antisocial adolescents. Future research should further investigate predictive factors for treatment outcomes regarding antisocial behaviours. Ultimately, this could provide better selection for treatment, evaluation of current programmes, or new treatment targets. In this regard, Vaske and colleagues (2011) have argued that there is a biological basis (e.g., executive functioning) for effective treatment of antisocial behaviours, although this was not confirmed by the current study.

Limitations of the study should be mentioned. The current study had a high rate of attrition due to missing behavioural information. It should be noted that high drop out and missing data is characteristic for research including severely antisocial adolescents due to the complex sample and study environment. Adolescents included in the current study all underwent tailored treatment based on the compulsory standard treatment programme. A standard basic environment is established and during the sequential stages of treatment adolescents received different additional treatment-components, suiting their individual needs and problems. As such, the current study investigated a heterogeneous group of adolescents varying in the additional treatment-components received. For most adolescents their complete treatment programme would include follow-up after leaving the residential facility, e.g., family-based

treatment programmes from home. As such, behavioural change measured within the current study might not fully be representative of the entire behavioural change or outcome. However, it should be noted that in general there is very little known about the adolescents ending up in compulsory residential treatment programmes due to severe problem behaviours.

Furthermore, it should be noted that EF consists of a range of functions and can be measured with a wide variety of tasks. The current study assessed three different EF concepts (i.e., shifting, inhibition and planning) with two well-known EF tasks. However, future research may benefit from including multiple EF tasks for each concept. The ‘diversity and unity’ of EF has been discussed earlier and different EF can contribute differentially to the performance of EF tasks (Miyake et al., 2000). Thus it should be noted that using different EF tasks might have resulted in different results. Future studies would benefit from including a wider range of EF tasks to address this issue, and should investigate the diversity in EF in relation to adolescent antisocial behaviour and treatment outcomes following residential treatment.

To our knowledge, the current study is one of few studies (Cornet et al., 2015; Fishbein et al., 2009; Mullin & Simpson, 2007) researching the predictive value of EF measures for antisocial behaviours after treatment. These studies have focused solely on adult antisocial populations (Cornet et al., 2015; Fishbein et al., 2009; Mullin & Simpson, 2007), with the exception of one study on young children (van Bokhoven et al., 2004). Furthermore, the current study investigated a unique sample of adolescents in the residential treatment programme for which little is known about the characteristics related to treatment outcome. Future studies should aim to include a higher number of antisocial adolescents with multiple measurements of behavioural problems throughout adolescence.

References

- Achenbach, T. M., Becker, A., Dopfner, M., Heiervang, E., Roessner, V., Steinhausen, H. C., & Rothenberger, A. (2008). Multicultural assessment of child and adolescent psychopathology with ASEBA and SDQ instruments: Research findings, applications, and future directions. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 49, 251–275. <http://doi.org/10.1111/j.1469-7610.2007.01867.x>
- Aharonovich, E., Hasin, D. S., Brooks, A. C., Liu, X., Bisaga, A., & Nunes, E. V. (2006). Cognitive deficits predict low treatment retention in cocaine dependent patients. *Drug and Alcohol Dependence*, 81(3), 313–322. <http://doi.org/10.1016/j.drugalcdep.2005.08.003>
- Álvarez-Moya, E. M., Ochoa, C., Jiménez-Murcia, S., Aymamí, M. N., Gómez-Peña, M., Fernández-Aranda, F., ... Menchón, J. M. (2011). Effect of executive functioning, decision-making and self-reported impulsivity on the treatment outcome of pathologic gambling. *Journal of Psychiatry and Neuroscience*, 36(3), 165–175. <http://doi.org/10.1503/jpn.090095>
- Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: a meta-analytic review. *Neuropsychology Review*, 16(1), 17–42. <http://doi.org/10.1007/s11065-006-9002-x>
- Bastiaanssen, I. L. W., Delsing, M. J. M. H., Kroes, G., Engels, R. C. M. E., & Veerman, J. W. (2014). Group care worker interventions and child problem behaviour in residential youth care: Course and bidirectional associations. *Children and Youth Services Review*, 39, 48–56. <http://doi.org/10.1016/j.childyouth.2014.01.012>
- Bergvall, A. H., Wessely, H., Forsman, A., & Hansen, S. (2001). A deficit in attentional set-shifting of violent offenders. In *Psychological medicine* (Vol. 31, pp. 1095–105). <http://doi.org/10.1017/S0033291701004317>
- Blair, R. J. R. (2004). The roles of orbital frontal cortex in the modulation of antisocial behaviour. *Brain and Cognition*. [http://doi.org/10.1016/S0278-2626\(03\)00276-8](http://doi.org/10.1016/S0278-2626(03)00276-8)
- Blair, R. J. R. (2010). Neuroimaging of psychopathy and antisocial behaviour: A targeted review. *Current Psychiatry Reports*, 12(1), 76–82. <http://doi.org/10.1007/s11920-009-0086-x>
- Cornet, L. J. M., van der Laan, P. H., Nijman, H. L. I., Tollenaar, N., & de Kogel, C. H. (2015). Neurobiological Factors as Predictors of Prisoners' Response to a Cognitive Skills Training. *Journal of Criminal Justice*, 43(2), 122–132. <http://doi.org/10.1016/j.jcrimjus.2015.02.003>
- De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J.-A., Proffitt, T. M., Mahony, K., & Pantelis, C. (2003). Normative data from the CANTAB. I: development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology*, 25(2), 242–54. <http://doi.org/10.1076/jcen.25.2.242.13639>
- Fairchild, G., Van Goozen, S. H. M., Calder, A. J., & Goodyer, I. M. (2013). Research Review: Evaluating and reformulating the developmental taxonomic theory of antisocial behaviour. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 54(9), 924–940. <http://doi.org/10.1111/jcpp.12102>

- Fishbein, D., Sheppard, M., Hyde, C., Hubal, R., Newlin, D., Serin, R., ... Alesci, S. (2009). Deficits in behavioural inhibition predict treatment engagement in prison inmates. *Law and Human Behaviour*, 33(5), 419–435. <http://doi.org/10.1007/s10979-008-9163-7>
- Goudriaan, A. E., Oosterlaan, J., De Beurs, E., & Van Den Brink, W. (2008). The role of self-reported impulsivity and reward sensitivity versus neurocognitive measures of disinhibition and decision-making in the prediction of relapse in pathological gamblers. *Psychological Medicine*, 38(1), 41–50. <http://doi.org/10.1017/S0033291707000694>
- Harder, A., Knorth, E. J. & Zandberg, T. (2006). *Residentiële jeugdzorg in beeld: Een overzichtsstudie naar de doelgroep, werkwijzen en uitkomsten* [Residential youth care in the picture: A review study of its target group, methods and outcomes]. Amsterdam: SWP Publishers, 2006.
- Heaton, R. K., Chleune, G. J., Taley, J. L., Kay, G. G., & Curtiss, G. (1993). Wisconsin card sorting test manual (Revised and expanded).
- Heyder, K., Suchan, B., & Daum, I. (2004). Cortico-subcortical contributions to executive control. *Acta Psychologica*, 115(2-3), 271–89. <http://doi.org/10.1016/j.actpsy.2003.12.010>
- Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017–2036. <http://doi.org/10.1016/j.neuropsychologia.2006.01.010>
- Huizinga, M., & van der Molen, M. W. (2007). Age-group differences in set-switching and set-maintenance on the Wisconsin Card Sorting Task. *Developmental Neuropsychology*, 31(2), 193–215. <http://doi.org/10.1080/87565640701190817>
- Jurado, M., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review*, 17(3), 213–233. <http://doi.org/10.1007/s11065-007-9040-z>
- Kim, M. S., Kim, J. J., & Kwon, J. S. (2001). Frontal P300 decrement and executive dysfunction in adolescents with conduct problems. *Child Psychiatry and Human Development*, 32(2), 93–106. <http://doi.org/10.1023/A:1012299822274>
- Knorth, E. J., Harder, A. T., Zandberg, T., & Kendrick, A. J. (2008). Under one roof: A review and selective meta-analysis on the outcomes of residential child and youth care. *Children and Youth Services Review*, 30(2), 123–140. <http://doi.org/10.1016/j.childyouth.2007.09.001>
- Krikorian, R., Bartok, J., & Gay, N. (1994). Tower of London procedure: a standard method and developmental data. *Journal of Clinical and Experimental Neuropsychology*, 16(6), 840–50. <http://doi.org/10.1080/01688639408402697>
- Lee, F. S., Heimer, H., Giedd, J. N., Lein, E. S., Šestan, N., Weinberger, D. R., & Casey, B. J. (2014). Mental health. Adolescent mental health—opportunity and obligation. *Science (New York, N.Y.)*, 346(6209), 547–9. <http://doi.org/10.1126/science.1260497>

- Lin, C. C., Chen, W. J., Yang, H. J., Hsiao, C. K., & Tien, A. Y. (2000). Performance on the Wisconsin Card Sorting Test among adolescents in Taiwan: norms, factorial structure, and relation to schizotypy. *Journal of Clinical and Experimental Neuropsychology*, 22(1), 69–79. [http://doi.org/10.1076/1380-3395\(200002\)22:1;1-8;FT069](http://doi.org/10.1076/1380-3395(200002)22:1;1-8;FT069)
- Lueger, R., & Gill, K. (1990). Frontal-lobe cognitive dysfunction in conduct disorder adolescents. *Journal of Clinical Psychology*, 46(6), 696–706.
- Menard, S. (1995). *Applied Logistic Regression Analysis* (Vol. 106). Sage Publications, Thousand Oaks, California. <http://doi.org/10.4135/9781412983433>
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal Lobe” tasks: a latent variable analysis. *Cognitive Psychology*, 41(1), 49–100. <http://doi.org/10.1006/cogp.1999.0734>
- Moffitt, T. E. (1993). The neuropsychology of conduct disorder. *Development and Psychopathology*, 5, 135. <http://doi.org/10.1017/S0954579400004302>
- Moffitt, T. E., & Caspi, a. (2001). Childhood predictors differentiate life-course persistent and adolescence-limited antisocial pathways among males and females. *Development and Psychopathology*, 13(2), 355–375. <http://doi.org/10.1017/S0954579401002097>
- Morgan, A. B., & Lilienfeld, S. O. (2000). A meta-analytic review of the relation between antisocial behaviour and neuropsychological measures of executive function. *Clinical Psychology Review*, 20(1), 113–136. [http://doi.org/10.1016/S0272-7358\(98\)00096-8](http://doi.org/10.1016/S0272-7358(98)00096-8)
- Mullin, S., & Simpson, J. (2007). Does executive functioning predict improvement in offenders’ behaviour following enhanced thinking skills training? An exploratory study with implications for rehabilitation. *Legal and Criminological Psychology*, 12(1), 117–131. <http://doi.org/10.1348/135532505X91560>
- Nijhof, K. S., Veerman, J. W., Engels, R. C. M. E., & Scholte, R. H. J. (2011). Compulsory residential care: An examination of treatment improvement of individual and family functioning. *Children and Youth Services Review*, 33(10), 1779–1785. <http://doi.org/10.1016/j.childyouth.2011.05.001>
- Ogders, C. L., Caspi, A., Broadbent, J. M., Dickson, N., Hancox, R. J., Harrington, H., ... Moffitt, T. E. (2007). Prediction of differential adult health burden by conduct problem subtypes in males. *Archives of General Psychiatry*, 64(4), 476–484. <http://doi.org/10.1001/archpsyc.64.4.476>
- Ogilvie, J. M., Stewart, A. L., Chan, R. C. K., & Shum, D. H. K. (2011). Neuropsychological measures of executive function and antisocial behaviour: A meta-analysis. *Criminology*, 49(4), 1063–1107. <http://doi.org/10.1111/j.1745-9125.2011.00252.x>

- Piquero, A. R. (2008). Taking stock of developmental trajectories of criminal activity over the life course. *The Long View of Crime: A Synthesis of Longitudinal Research*, 23–78. http://doi.org/10.1007/978-0-387-71165-2_2
- Séguin, J. R., Pinsonneault, M., Parent, S., & Séguin, J. R. (2015). Executive function and intelligence in the development of antisocial behaviour. *The Development of Criminal and Antisocial Behaviour: Theory, Research and Practical Applications*, 123–135. http://doi.org/10.1007/978-3-319-08720-7_9
- Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., & Schwab-Stone, M. E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39(1), 28–38. <http://doi.org/10.1097/00004583-200001000-00014>
- Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 298(1089), 199–209. <http://doi.org/10.1098/rstb.1982.0082>
- Slot, W., & Spanjaard, H. (1999). *Competentievergroting in de residentiele jeugdzorg. Hulpverlening voor kinderen en jongeren in tehuizen*. Baarn: Intro.
- Souverein, F. A., Van der Helm, G. H. P., & Stams, G. J. J. M. (2013). “Nothing works” in secure residential youth care? *Children and Youth Services Review*, 35(12), 1941–1945. <http://doi.org/10.1016/j.childyouth.2013.09.010>
- Steinmetz, J.-P., & Houssemand, C. (2011). What about inhibition in the Wisconsin Card Sorting Test? *The Clinical Neuropsychologist*, 25(4), 652–69. <http://doi.org/10.1080/13854046.2011.568525>
- Strauss, E. H., Sherman, E. M. S., & Spreen, O. (2006). A Compendium of Neuropsychological Tests. *Administration Norms And Commentary*. Oxford University Press.
- Turner, T. H., LaRowe, S., Horner, M. D., Herron, J., & Malcolm, R. (2009). Measures of cognitive functioning as predictors of treatment outcome for cocaine dependence. *Journal of Substance Abuse Treatment*, 37(4), 328–334. <http://doi.org/10.1016/j.jsat.2009.03.009>
- van Bokhoven, I., Matthys, W., van Goozen, S. H. M., & van Engeland, H. (2004). Prediction of treatment outcome in children with disruptive behaviour disorders: An exploratory study. (Unpublished Doctoral Dissertation). Universitair Medisch Centrum Utrecht, Netherlands. <http://doi.org/10.1007/s00787-005-0455-x>
- van der Oord, S., Geurts, H. M., Prins, P. J. M., Emmelkamp, P. M. G., & Oosterlaan, J. (2012). Prepotent response inhibition predicts treatment outcome in attention deficit/hyperactivity disorder. *Child Neuropsychology*, 18(1), 50–61. <http://doi.org/10.1080/09297049.2011.559159>

- Vaske, J., Galyean, K., & Cullen, F. T. (2011). Toward a biosocial theory of offender rehabilitation: Why does cognitive-behavioural therapy work? In *Journal of Criminal Justice* (Vol. 39, pp. 90–102). <http://doi.org/10.1016/j.jcrimjus.2010.12.006>
- Verhulst, FC, Van der Ende, J, Koot, H. (1996). *Handleiding voor de CBCL/4–18 (Manual for the CBCL/4–18)*. fdeling Kinder-en jeugdpsychiatrie, Sophia Kinderziekenhuis/Academisch Ziekenhuis Rotterdam/Erasmus Universiteit Rotterdam, Rotterdam, the Netherlands.
- Yang, Y., & Raine, A. (2009). Prefrontal structural and functional brain imaging findings in antisocial, violent, and psychopathic individuals: A meta-analysis. *Psychiatry Research - Neuroimaging*. <http://doi.org/10.1016/j.psychresns.2009.03.012>
- Achenbach, T. M., Becker, A., Dopfner, M., Heiervang, E., Roessner, V., Steinhausen, H. C., & Rothenberger, A. (2008). Multicultural assessment of child and adolescent psychopathology with ASEBA and SDQ instruments: Research findings, applications, and future directions. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 49, 251–275. <http://doi.org/10.1111/j.1469-7610.2007.01867.x>
- Aharonovich, E., Hasin, D. S., Brooks, A. C., Liu, X., Bisaga, A., & Nunes, E. V. (2006). Cognitive deficits predict low treatment retention in cocaine dependent patients. *Drug and Alcohol Dependence*, 81(3), 313–322. <http://doi.org/10.1016/j.drugalcdep.2005.08.003>
- Álvarez-Moya, E. M., Ochoa, C., Jiménez-Murcia, S., Aymamí, M. N., Gómez-Peña, M., Fernández-Aranda, F., ... Menchón, J. M. (2011). Effect of executive functioning, decision-making and self-reported impulsivity on the treatment outcome of pathologic gambling. *Journal of Psychiatry and Neuroscience*, 36(3), 165–175. <http://doi.org/10.1503/jpn.090095>
- Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: a meta-analytic review. *Neuropsychology Review*, 16(1), 17–42. <http://doi.org/10.1007/s11065-006-9002-x>
- Bastiaanssen, I. L. W., Delsing, M. J. M. H., Kroes, G., Engels, R. C. M. E., & Veerman, J. W. (2014). Group care worker interventions and child problem behaviour in residential youth care: Course and bidirectional associations. *Children and Youth Services Review*, 39, 48–56. <http://doi.org/10.1016/j.chilyouth.2014.01.012>
- Bergvall, A. H., Wessely, H., Forsman, A., & Hansen, S. (2001). A deficit in attentional set-shifting of violent offenders. In *Psychological medicine* (Vol. 31, pp. 1095–105). <http://doi.org/10.1017/S0033291701004317>
- Blair, R. J. R. (2004). The roles of orbital frontal cortex in the modulation of antisocial behaviour. *Brain and Cognition*. [http://doi.org/10.1016/S0278-2626\(03\)00276-8](http://doi.org/10.1016/S0278-2626(03)00276-8)
- Blair, R. J. R. (2010). Neuroimaging of psychopathy and antisocial behaviour: A targeted review. *Current Psychiatry Reports*, 12(1), 76–82. <http://doi.org/10.1007/s11920-009-0086-x>
- Cornet, L. J. M., van der Laan, P. H., Nijman, H. L. I., Tollenaar, N., & de Kogel, C. H. (2015). Neurobiological Factors as Predictors of Prisoners' Response to a Cognitive Skills Training. *Journal of Criminal Justice*, 43(2), 122–132. <http://doi.org/10.1016/j.jcrimjus.2015.02.003>

- De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J.-A., Proffitt, T. M., Mahony, K., & Pantelis, C. (2003). Normative data from the CANTAB. I: development of executive function over the lifespan. *Journal of Clinical and Experimental Neuropsychology*, 25(2), 242–54. <http://doi.org/10.1076/j.jcen.25.2.242.13639>
- Fairchild, G., Van Goozen, S. H. M., Calder, A. J., & Goodyer, I. M. (2013). Research Review: Evaluating and reformulating the developmental taxonomic theory of antisocial behaviour. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 54(9), 924–940. <http://doi.org/10.1111/jcpp.12102>
- Fishbein, D., Sheppard, M., Hyde, C., Hubal, R., Newlin, D., Serin, R., ... Alesci, S. (2009). Deficits in behavioural inhibition predict treatment engagement in prison inmates. *Law and Human Behaviour*, 33(5), 419–435. <http://doi.org/10.1007/s10979-008-9163-7>
- Goudriaan, A. E., Oosterlaan, J., De Beurs, E., & Van Den Brink, W. (2008). The role of self-reported impulsivity and reward sensitivity versus neurocognitive measures of disinhibition and decision-making in the prediction of relapse in pathological gamblers. *Psychological Medicine*, 38(1), 41–50. <http://doi.org/10.1017/S0033291707000694>
- Harder, A., Knorth, E. J. & Zandberg, T. (2006). *Residentiele jeugdzorg in beeld: Een overzichtsstudie naar de doelgroep, werkwijzen en uitkomsten* [Residential youth care in the picture: A review study of its target group, methods and outcomes]. Amsterdam: SWP Publishers, 2006.
- Heaton, R. K., Chleune, G. J., Taley, J. L., Kay, G. G., & Curtiss, G. (1993). Wisconsin card sorting test manual (Revised and expanded).
- Heyder, K., Suchan, B., & Daum, I. (2004). Cortico-subcortical contributions to executive control. *Acta Psychologica*, 115(2-3), 271–89. <http://doi.org/10.1016/j.actpsy.2003.12.010>
- Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017–2036. <http://doi.org/10.1016/j.neuropsychologia.2006.01.010>
- Huizinga, M., & van der Molen, M. W. (2007). Age-group differences in set-switching and set-maintenance on the Wisconsin Card Sorting Task. *Developmental Neuropsychology*, 31(2), 193–215. <http://doi.org/10.1080/87565640701190817>
- Jurado, M., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review*, 17(3), 213–233. <http://doi.org/10.1007/s11065-007-9040-z>
- Kim, M. S., Kim, J. J., & Kwon, J. S. (2001). Frontal P300 decrement and executive dysfunction in adolescents with conduct problems. *Child Psychiatry and Human Development*, 32(2), 93–106. <http://doi.org/10.1023/A:1012299822274>
- Knorth, E. J., Harder, A. T., Zandberg, T., & Kendrick, A. J. (2008). Under one roof: A review and selective meta-analysis on the outcomes of residential child and youth care. *Children and Youth Services Review*, 30(2), 123–140. <http://doi.org/10.1016/j.childyouth.2007.09.001>

- Krikorian, R., Bartok, J., & Gay, N. (1994). Tower of London procedure: a standard method and developmental data. *Journal of Clinical and Experimental Neuropsychology*, 16(6), 840–850. <http://doi.org/10.1080/01688639408402697>
- Lee, F. S., Heimer, H., Giedd, J. N., Lein, E. S., Šestan, N., Weinberger, D. R., & Casey, B. J. (2014). Mental health. Adolescent mental health—opportunity and obligation. *Science (New York, N.Y.)*, 346(6209), 547–9. <http://doi.org/10.1126/science.1260497>
- Lin, C. C., Chen, W. J., Yang, H. J., Hsiao, C. K., & Tien, A. Y. (2000). Performance on the Wisconsin Card Sorting Test among adolescents in Taiwan: norms, factorial structure, and relation to schizotypy. *Journal of Clinical and Experimental Neuropsychology*, 22(1), 69–79. [http://doi.org/10.1076/1380-3395\(200002\)22:1;1-8;FT069](http://doi.org/10.1076/1380-3395(200002)22:1;1-8;FT069)
- Lueger, R., & Gill, K. (1990). Frontal-lobe cognitive dysfunction in conduct disorder adolescents. *Journal of Clinical Psychology*, 46(6), 696–706.
- Menard, S. (1995). *Applied Logistic Regression Analysis* (Vol. 106). Sage Publications, Thousand Oaks, California. <http://doi.org/10.4135/9781412983433>
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal Lobe” tasks: a latent variable analysis. *Cognitive Psychology*, 41(1), 49–100. <http://doi.org/10.1006/cogp.1999.0734>
- Moffitt, T. E. (1993). The neuropsychology of conduct disorder. *Development and Psychopathology*, 5, 135. <http://doi.org/10.1017/S0954579400004302>
- Moffitt, T. E., & Caspi, a. (2001). Childhood predictors differentiate life-course persistent and adolescence-limited antisocial pathways among males and females. *Development and Psychopathology*, 13(2), 355–375. <http://doi.org/10.1017/S0954579401002097>
- Morgan, A. B., & Lilienfeld, S. O. (2000). A meta-analytic review of the relation between antisocial behaviour and neuropsychological measures of executive function. *Clinical Psychology Review*, 20(1), 113–136. [http://doi.org/10.1016/S0272-7358\(98\)00096-8](http://doi.org/10.1016/S0272-7358(98)00096-8)
- Mullin, S., & Simpson, J. (2007). Does executive functioning predict improvement in offenders’ behaviour following enhanced thinking skills training? An exploratory study with implications for rehabilitation. *Legal and Criminological Psychology*, 12(1), 117–131. <http://doi.org/10.1348/135532505X91560>
- Nijhof, K. S., Veerman, J. W., Engels, R. C. M. E., & Scholte, R. H. J. (2011). Compulsory residential care: An examination of treatment improvement of individual and family functioning. *Children and Youth Services Review*, 33(10), 1779–1785. <http://doi.org/10.1016/j.chilyouth.2011.05.001>

- Odgers, C. L., Caspi, A., Broadbent, J. M., Dickson, N., Hancox, R. J., Harrington, H., ... Moffitt, T. E. (2007). Prediction of differential adult health burden by conduct problem subtypes in males. *Archives of General Psychiatry*, 64(4), 476–484. <http://doi.org/10.1001/archpsyc.64.4.476>
- Ogilvie, J. M., Stewart, A. L., Chan, R. C. K., & Shum, D. H. K. (2011). Neuropsychological measures of executive function and antisocial behaviour: A meta-analysis. *Criminology*, 49(4), 1063–1107. <http://doi.org/10.1111/j.1745-9125.2011.00252.x>
- Piquero, A. R. (2008). Taking stock of developmental trajectories of criminal activity over the life course. *The Long View of Crime: A Synthesis of Longitudinal Research*, 23–78. http://doi.org/10.1007/978-0-387-71165-2_2
- Séguin, J. R., Pinsonneault, M., Parent, S., & Séguin, J. R. (2015). Executive function and intelligence in the development of antisocial behaviour. *The Development of Criminal and Antisocial Behaviour: Theory, Research and Practical Applications*, 123–135. http://doi.org/10.1007/978-3-319-08720-7_9
- Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., & Schwab-Stone, M. E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39(1), 28–38. <http://doi.org/10.1097/00004583-200001000-00014>
- Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 298(1089), 199–209. <http://doi.org/10.1098/rstb.1982.0082>
- Slot, W., & Spanjaard, H. (1999). *Competentievergroting in de residentiële jeugdzorg. Hulpverlening voor kinderen en jongeren in tehuizen*. Baarn: Intro.
- Souverein, F. A., Van der Helm, G. H. P., & Stams, G. J. J. M. (2013). “Nothing works” in secure residential youth care? *Children and Youth Services Review*, 35(12), 1941–1945. <http://doi.org/10.1016/j.childyouth.2013.09.010>
- Steinmetz, J.-P., & Houssemand, C. (2011). What about inhibition in the Wisconsin Card Sorting Test? *The Clinical Neuropsychologist*, 25(4), 652–69. <http://doi.org/10.1080/13854046.2011.568525>
- Strauss, E. H., Sherman, E. M. S., & Spreen, O. (2006). *A Compendium of Neuropsychological Tests. Administration Norms And Commentary*. Oxford University Press.
- Turner, T. H., LaRowe, S., Horner, M. D., Herron, J., & Malcolm, R. (2009). Measures of cognitive functioning as predictors of treatment outcome for cocaine dependence. *Journal of Substance Abuse Treatment*, 37(4), 328–334. <http://doi.org/10.1016/j.jsat.2009.03.009>

- van Bokhoven, I., Matthys, W., van Goozen, S. H. M., & van Engeland, H. (2004). Prediction of treatment outcome in children with disruptive behaviour disorders: An exploratory study. (*Unpublished Doctoral Dissertation*). *Universitair Medisch Centrum Utrecht, Netherlands*. <http://doi.org/10.1007/s00787-005-0455-x>
- van der Oord, S., Geurts, H. M., Prins, P. J. M., Emmelkamp, P. M. G., & Oosterlaan, J. (2012). Prepotent response inhibition predicts treatment outcome in attention deficit/hyperactivity disorder. *Child Neuropsychology*, 18(1), 50–61. <http://doi.org/10.1080/09297049.2011.559159>
- Vaske, J., Galyean, K., & Cullen, F. T. (2011). Toward a biosocial theory of offender rehabilitation: Why does cognitive-behavioural therapy work? In *Journal of Criminal Justice* (Vol. 39, pp. 90–102). <http://doi.org/10.1016/j.jcrimjus.2010.12.006>
- Verhulst, FC, Van der Ende, J, Koot, H. (1996). *Handleiding voor de CBCL/4–18 (Manual for the CBCL/4–18)*. fdeling Kinder-en jeugdpsychiatrie, Sophia Kinderziekenhuis/Academisch Ziekenhuis Rotterdam/Erasmus Universiteit Rotterdam, Rotterdam, the Netherlands.
- Yang, Y., & Raine, A. (2009). Prefrontal structural and functional brain imaging findings in antisocial, violent, and psychopathic individuals: A meta-analysis. *Psychiatry Research - Neuroimaging*. <http://doi.org/10.1016/j.psychresns.2009.03.012>